GRAZING IN DUNE AREAS: THE OBJECTIVES OF NATURE CONSERVATION AND THE AIMS OF RESEARCH FOR NATURE CONSERVATION MANAGEMENT

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Introduction

Management for nature conservation in the context of the present paper can have two objectives: to maintain the quality of the environment, ultimately for species conservation, in nature reserves or to restore, improve or develop such qualities in areas recently set apart for nature conservation. Such areas include abandoned fields, former agricultural lands and recently reclaimed areas e.g. as found in the coastal areas in The Netherlands.

Crucial issues in this respect are the questions 'What is quality?' and 'How can quality be measured?'. Quality can be defined by the natural value i.e. the 'use value' for species of importance from the nature conservation point of view. The natural value of an area increases with the number of such species that can make use of the reserve. Evaluation criteria such as diversity, rarity and ecological fragility are strongly related to this general objective. The biological diversity of spontaneous origin is often used as a measure for the evaluation of areas (Margules & Usher 1984).

The next point is: Which management practices are the most appropriate? Apart from the criteria mentioned above, the recorded cultural history, amenity value and not least the applicability with respect to costs are of importance.

Before focussing on grazing as a nature conservation management practice in coastal regions, some general features in the mutual relations between herbivores and vegetation have to be considered.

General aspects of grazing as a mangement tool

The statements below combine the results of 15 years of reasearch on grazing in a wide variety of habitats (salt marshes, sand dunes, heath - the moorland, marshes, former agricultural areas) ranging in size from a few to several hundreds of hectares. In these areas grazing with livestock such as cattle, horses, sheep and goats is applied under varying methods (continuous, seasonal, mixed grazing).

The research programme often included comparison with the development in areas under other types of management, e.g. cutting or no management at all. Very little has so far been published in English (cf. Oosterveld 1983) but accounts in Dutch are available (Oosterveld 1977, 1979) sometimes with an English summary (Thalen 1984).

Without human or large herbivore interference the vegetation structurally develops from 'short' via 'rough' to 'bush' and finally at most places of our latitude, to 'woodland'. Under a cutting management regime a short structural pattern is maintained. In both these extreme cases the variety in the vegetation will be governed by the environmental conditions at the locality. In terms of structural patterns the vegetation and thereby the terrain conditons are mostly rather monotonous. By contrast grazing has an important effect on the vegetation by introducing pattern diversification, induced and enhanced by uneven trampling, dunging and grazing. The vegetation may develop structurally in different directions (Fig 1).

Differences in pattern can be further enhanced (1) by weather conditions e.g. wind and water impact, (2) by the activities of small faunal elements such as ants, and (3) by the continued grazing. The conditions for plant growth change differently from place to place and the floristic compostion will change with it. Differences caused by trampling i.e. creating a range of different states of soil compaction, seem to be a most important factor with respect to the main objective: maintaining growth conditions for species of interest from the nature conservation point of view.

Pattern diversification in grazed areas developes, and the patterns are fixed, under the rather constant animal use of the area through the seasons and over the years. When a classification is made of animal-hours spent in areas (blocks) of the same size, the non-random use of the area can be demonstrated (Fig 2).

A comparison of the vegetation in grazed plots with cutting - or no-management plots shows a higher plant species diversity under grazing (Bakker et al. 1983, Slim & Oosterveld 1985, Willems 1983).

There is also evidence that grazed plots have a higher stability with vegetation changes due to occasionally extreme climatic conditions being far less dramatic.

Cattle and horses prefer to graze facing away from the sun (Table 1). In large grazing areas this results in a daily clockwise pattern of herd movement. Deviations may occur as a result of natural barriers in the area or sites of specific interest for the animals such as a drinking place or the only few trees providing shelter. During midday most animals can be found in the northern quadrant of the area, while sleeping places will

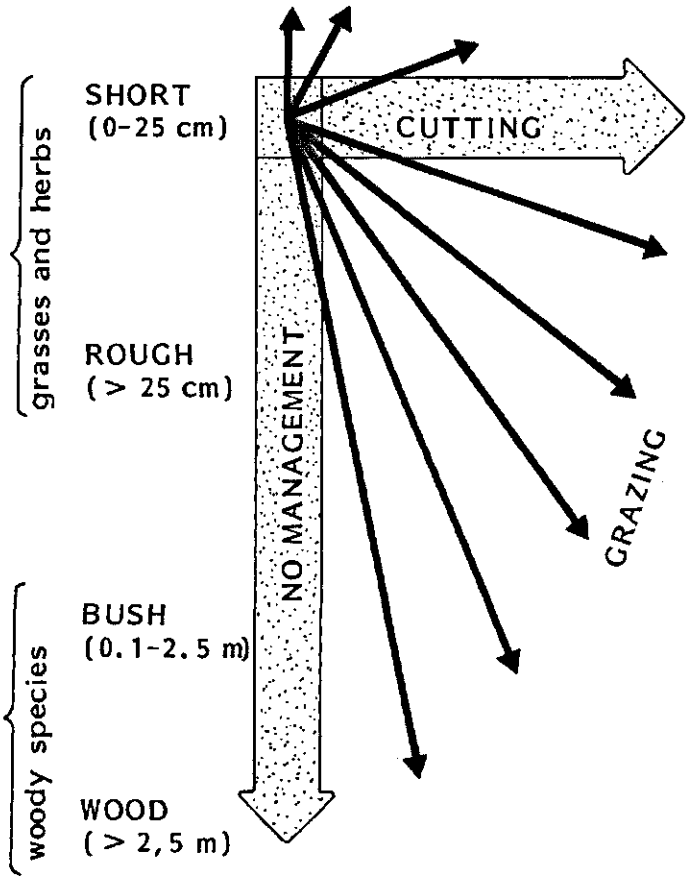
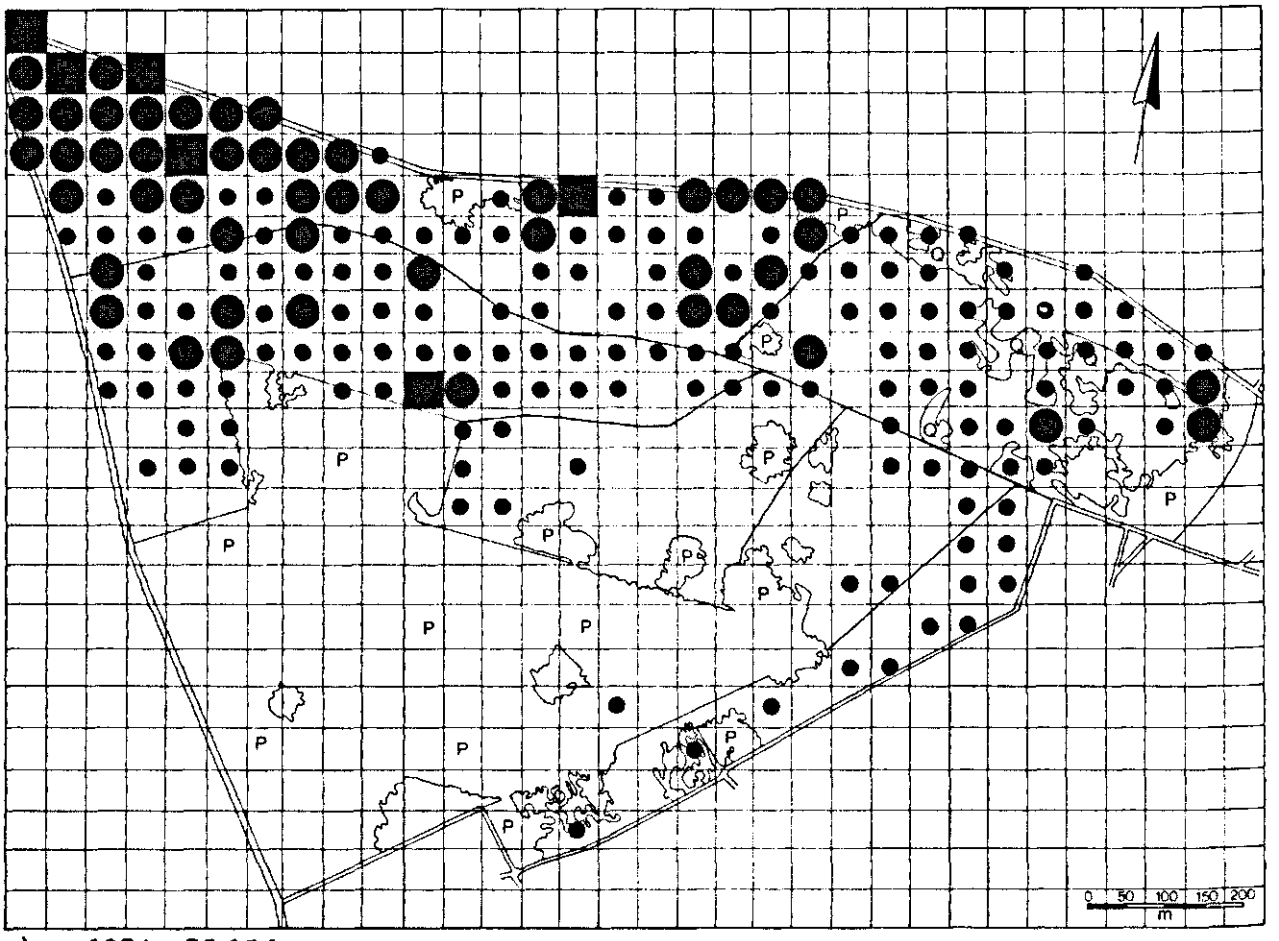


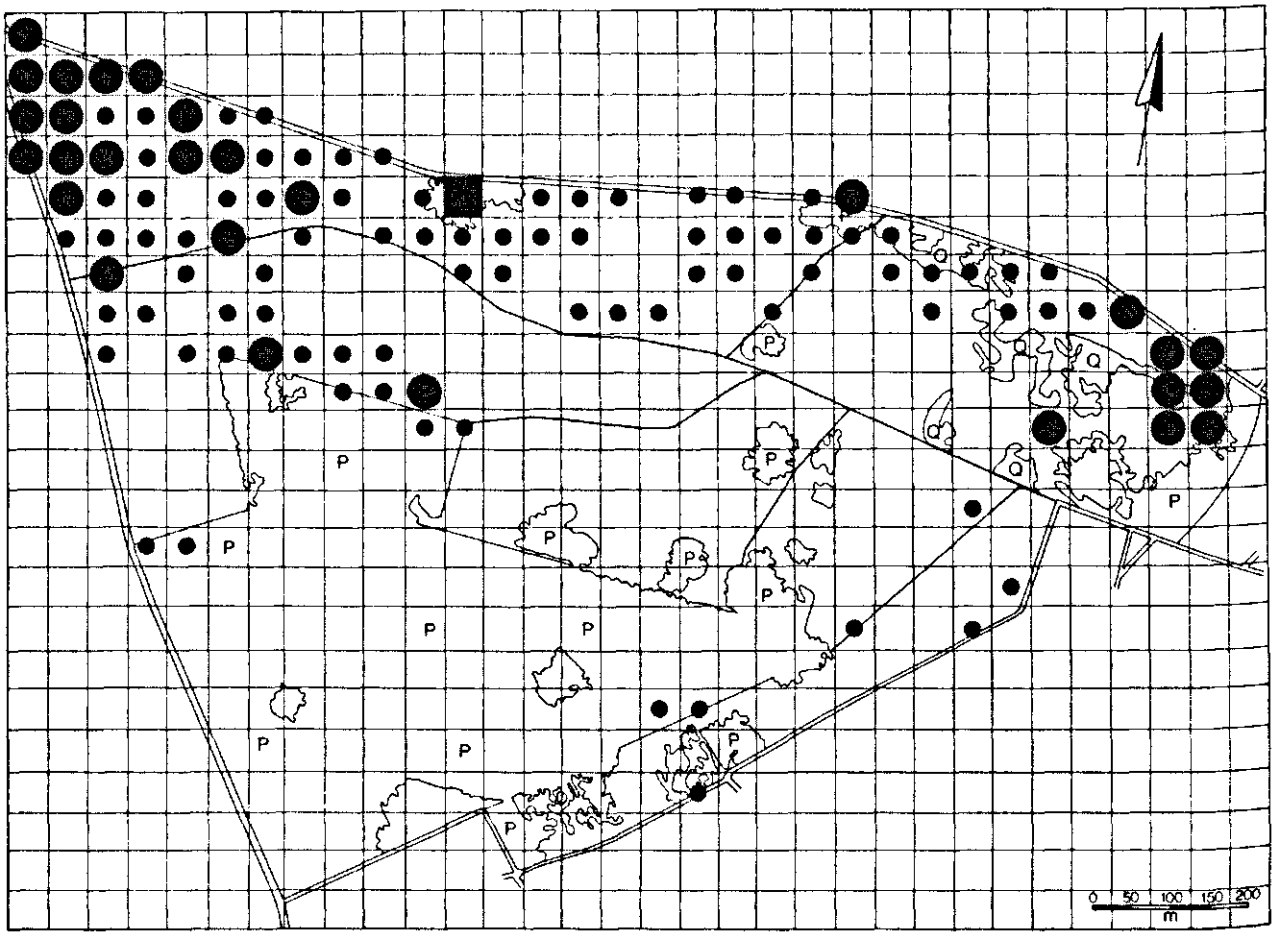
Figure 1

Structural pattern of vegetation in relation to different management practices.

Figure 2
Number of animal - hours spent in uniform areas.



a) 1974 - 75 15 horses



b) 1980 - 81 8 horses

HEAVY MODERATE LIGHT VERY LIGHT-NO

mostly be established in the south eastern parts. This phenonmenon enables the terrain managers to predict which parts of the area will receive the heaviest pressure. Through proper planning of a grazing management scheme, for instance, it can be arranged that the most vulnerable vegetation types are not situated at the border of the area, especially in the heavily used northern and south-eastern parts.

Table 1

Animals grazing in a certain direction (%); cattle n=440

	(one quadrant) facing away from the sum	(one quadrant) facing the sun	(two quadrants) perpendicular to the direction of the sunlight
Expected random distribution	25	25	50
Early morning, late afternoon	70	10	20
Midday	58	12	30

Grazing animals create their own specific vegetation patterns. Under increasing stocking rates the pattern boundaries become gradually sharper but eventually disappear when the pressure becomes too heavy. It is the author's opinion that under similar conditions, when compared to other livestock species cattle will create the greatest differences in this respect.

Data on longterm stocking rates and the resulting vegetation patterns are hard to find in grazing literature. For practical reasons the author developed and defined standards based on land use practices in the past (Table 2).

Table 2

Use-intensity under four stocking rate classes
(percentages of the available surface)

Stocking rate (animals ha-1)			Use-intensity			
	sheep	cattle/horses	heavy	moderate	light	very light
heavy	3	1	80	15	5	-
moderate	1-3	0.3.-1	20	50	25	5
low	0.2-1	0.1-0.3	5	15	50	30
very low	0.2	0.1	(1)	10	25	65

The effects on the structural pattern of the vegetation can be worked out by comparing blocks of different use intensity (Fig 2) after some years. Lightly used parts showed for instance a development to a structural parttern in which 10% of the surface retains a short structure, 50% develops into a rough vegetation, 30% develops into bush and 10% will become woodland after 25 years and more (Table 3).

Table 3

Final structural pattern (% of total surface) of the vegetation under different use-intensities

Use-intensity	SHORT	ROUGH	BUSH	WOODLAND
heavy	100	-	-	-
moderate	80	20	-	-
light	10	50	30	10
very light/no use	5	10	20	65

The short/rough distribution stabilizes in about 5 years (Bakker et al. 1983). Under the prevailing conditions on rather poor soils in The Netherlands developments to bushland are estimated to take 5 to 25 years and to woodland up to 100 years. Figures on the distribution of the use intensity prove constant for a number of areas so far tested in The Netherlands (Table 4).

Table 4

Use-intensity of different terrains under grazing at low-stocking rates

livestock species	total area grazed	use-intensity (%) heavy	moderate	light	very light
cattle	300 ha	6	12	57	25
horses	100 ha	3	10	60	27
sheep	230 ha	3	12	50	35
sheep	3 ha	6	34	40	20

The stocking rate and, to a lesser degree, the size of the area seem to be important. Classes of use intensity are defined in the same way as for stocking rate: e.g. parts of the area are used heavily when on an average over the year more than 3 sheep ha^{-1} or more than 1 cow ha^{-1} are present, etc. (Table 2).

Using the parameters 'use-intensity' for animals and 'structural pattern' for vegetation, developments in quite different areas grazed by different animal species at various densities can be compared. At the Research Institute for Nature Management a modelling approach is now being followed to work out the structural changes in the vegetation that may be expected under different levels of animal use (Lotz & Poorter 1983). An example of the output of one of the models is given in Figure 3. As far as can be ascertained at present, the results of this type of modelling are close to reality. Validation is hardly possible due to the absence of reliable long-term data on stocking rates, the additional management practices applied (cutting of bushes, mowing of rough vegetation), etc. Moreover, aerial photography to quantify the changes in the structural patterns of the vegetation over the years is only available from comparatively recent dates. Research along this line is however continuing.

A great deal of improvements still have to be made but the main parameters and parameter values used in the models seem to be suitable for use in planning nature conservation management practices under a wide variety of conditions. Parameters such as phytomass production, herbage and browse quality, availability of the forage and selectivity of the animals are incorporated in the models. In one model this has been done in a separate 'parameter' way, in another one in a more integrated pragmatic way based on field observation.

Grazing in coastal regions in relation to management problems

Differences between grazed and ungrazed vegetation in dune and saltmarsh areas are always striking. In the lower parts of the saltmarsh vegetation types are completely different and at higher levels the grazed areas of dune-saltmarsh transitions show far more variation (Fig 4). If grazing stops a levelling of vegetation structural patterns can be observed. After some years an increase of humus content in the topsoil layer, due to the accumulation of dead material, is evident, which gradually results in changes in the floristic compostion. As a rule more species will disappear than new ones establish. Apart from the increase of amenity value, during the first year only, cessation of grazing management thwarts the interests of nature conservation.

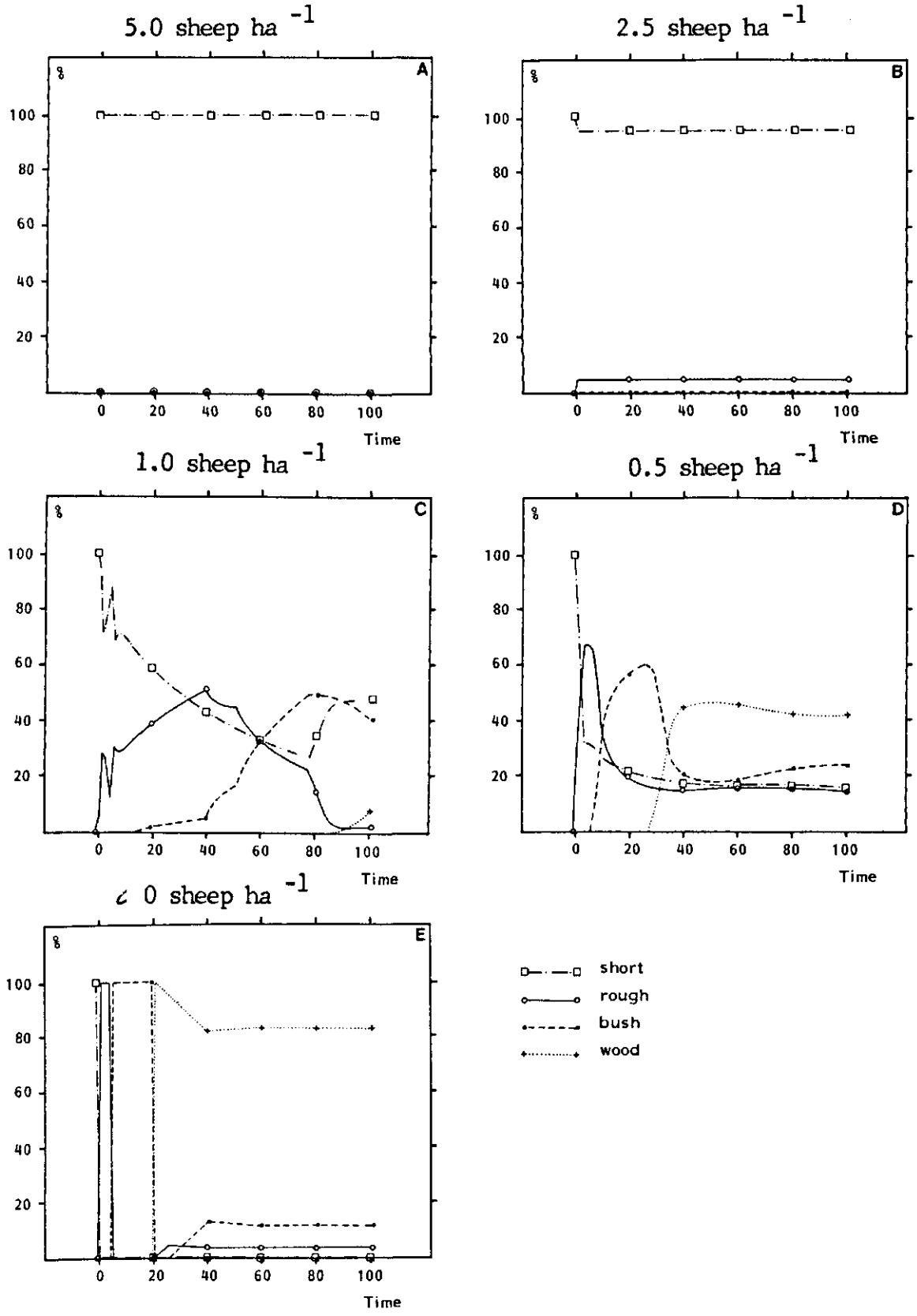


Figure 3

Simulations of vegetation development under different stocking rates (Mat - 2 program (from Lotz and Porter 1983)).

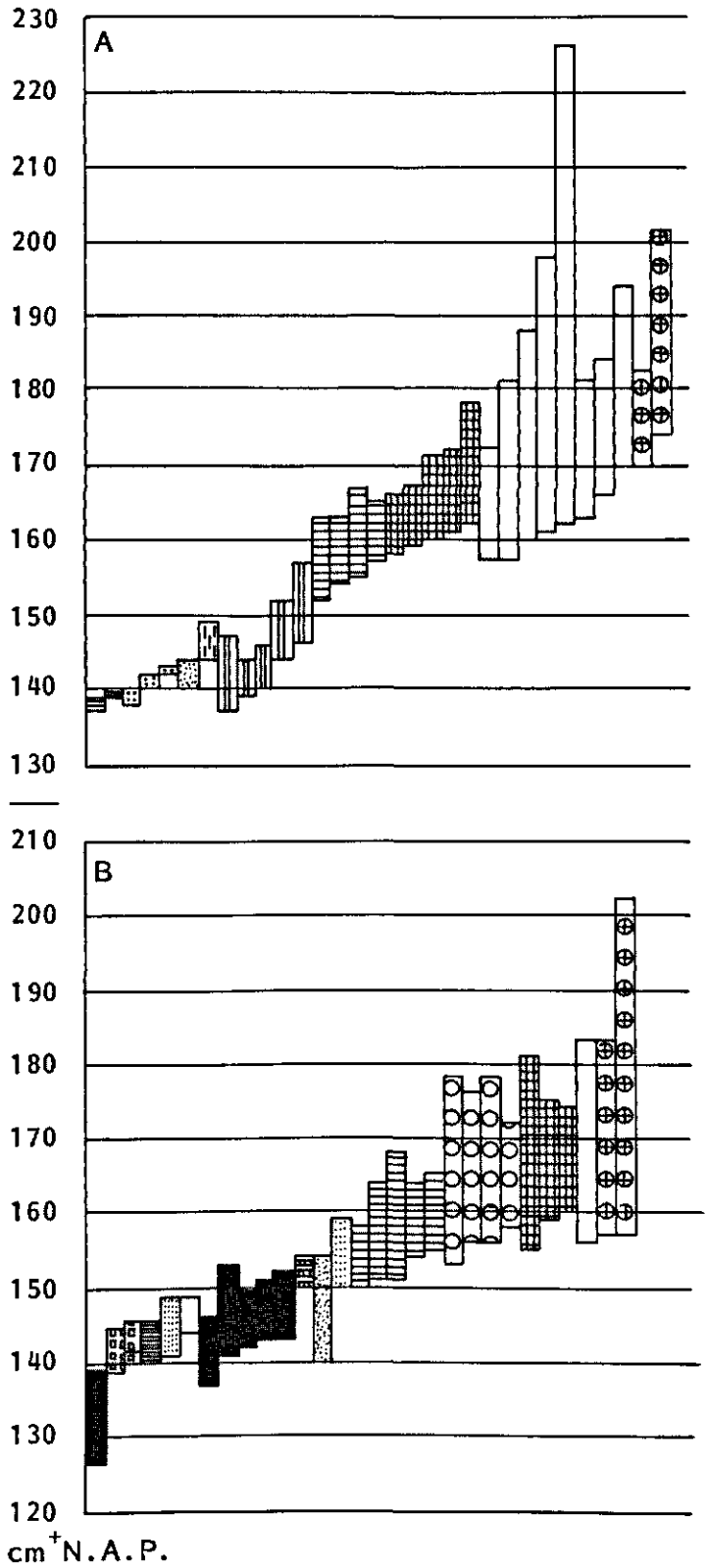


Figure 4

Variation in vegetation communities on a saltmarsh - dune transition under grazed (B) and ungrazed (A) conditions.

In order to maintain the natural value of grazed areas no additional management to improve the grazing for animals (and profit for the farmers) should be applied. Use of fertilizers, drainage and levelling of natural relief lead to loss of quality of the natural vegetation. A very gradual decrease of the stocking rate may improve environmental conditions for species in the interest of nature conservation. A comparison of the grazed dune-saltmarsh areas in The Netherlands shows that those with low seasonal stocking rates have on average higher species diversity and rare species occurrence than the more intensely used ones. Direct correlations between stocking rates and natural value are however rather difficult to establish, since past agricultural 'improvements' can have far reaching consequences.

In an area on the Frisian island of Terschelling, already seasonally grazed for a large number of years at a rate of 0.3 cattle per hectare, the number of animals was doubled in 1975. It was observed that parts of the area which were already under a heavy pressure were then used even more intensively. This resulted in a tenfold increase in the area of exposed sand where the vegetation was lost due to trampling. However, the rare plants in the area (Tuberaria guttata, various species of orchids, Eryngium maritimum, Calystegia soldanella, Bupleurum tenuissimum) are present as before now, ten years later. Close to the trampled areas, an increased diversity can be seen due to the local deposition of windblown sand in moist dune heath vegetation. Salix repens shrub is now more intensively used in autumn which results locally in bare patches, where rather rare annuals such as Centunculus minimus may occur the next year in large numbers. In areas which have been grazed for several decades, the basic stocking rate seems to be of less importance to the survival of the natural vegetation slight 'overgrazing' need not be harmful from a nature conservation point of view as long as the techniques for 'improvement' mentioned above are not applied and the animals can obtain sufficient food from the available vegetation. Harmful overgrazing effects may occur if animals can be kept in the field only with the help of supplementary feeding.

For seasonal grazing in dune-saltmarsh areas (May to November) low to moderate stocking rates can be applied (up to one animal per ha for cattle or horses, up to three animals per ha for sheep). Year-round grazing in dune areas without additional feeding is, during wintertime only possible at very low stocking rates (one animal per 10 ha for cattle and horses, one animal per 5 ha for sheep). Due to their ability to compensate for low-quality fodder by taking higher quantities, horse are most suitable for year-round grazing regimes.

Shrub encroachment

What should be done if species-rich duneslack communities gradually change into less desirable monotonous shrub vegetation? Attempting to retain grazing of these areas, when animals would move away naturally is as a rule not an appropriate method. If new suitable habitats are expected to develop elsewhere in the area (very likely in dynamic dune areas) there is no reason at all for concern. By cutting the scrub a short structural pattern will be maintained but internal differentiation decreases. Moreover, germinating and regrowth of shrubs are then often stimulated. Grazing cannot entirely prevent the shrub development but offers the best conditions at the same locality for maintaining rare species of duneslack communities. Under a grazing regime even halophytic species can survive long after all direct salination influences have ceased (Westhoff and Sykora 1979).

When dune-shrub, especially Hippophae rhamnoides, expands in areas with little abiotic variation, complete dominance can be reached quite quickly. If such areas are grazed from the beginning a diversified vegetation pattern will emerge. The shrub development is strongly retarded and the shrub vegetation which comes through is far more variable. A new flat area in the Grevelingen lake (SW-Netherlands) under permanent low-stocking rate grazing with cattle (one animal per 20 ha) has developed into an extensive duneslack vegetation in which a number of rare species established spontaneously (Centaurium litorale, C. minus, C. pulchellum, Gnaphalium luteo-album, Sagina nodosa, S. maritima, Epipactis palustris, Parnassia palustris, Dianthus armeria, Blackstonia perfoliata). After 12 years, shrubs and trees start to develop (Slim & Oosterveld 1985). No grazing animal can prevent on its own all tree growth and shrub development in any sizeable area. With specific methods, however, shrub development can be influenced and largely controlled by grazing.

In grazed dune-heath vegetation, birches (Betula spp.) of considerable age (up to 45 years) may occur without emerging from the surrounding heath. Shrub development can be retarded considerably by increasing the stocking rates in autumn. During that period herbs and grasses between the shrubs are more nutritious than in the open field and the animals will respond. With help of a flock of sheep tree growth in dune-heath vegetation can be prevented if the area is grazed at the right time of the year (March-April for removing Scotch pine trees, April-May and a few days in autumn for removing deciduous tree species). It should be kept in mind, however, that such specific methods involve higher costs of management.

Problems raised in relation to birds

Very often changes in management are proposed in order to improve the life conditions for birds in an area. In this respect grazing management is considered beneficial as well as disadvantageous, depending on how the management is applied and what bird species are present. For a dune-saltmarsh area on the Frisian island of Ameland grazed by young cattle it was proposed that grazing should stop in the dune, partly because of its eroding effects and partly because in the moist valleys wader bird nests were trampled. Both arguments were wrong from a nature conservation point of view and would lead to quite opposite effects from those which were desired. For conservation of the whole plant succession, dunes must be kept on the move, at least locally. Grazing animals who trample rabbit burrows can be of great help in this respect. Even if some bird nests are trampled, it should be realized that there would not have been any nest without grazing: across the fence on the other side of the moist valley dense willow shrub has replaced all foraging and nesting habitat for wader birds, Methods aimed at protecting one species from trampling by excluding animals from the area where this species occurs usually do not produce the intended result.

Rabbit grazing in dunes

In many dune areas rabbits are very important in maintaining the variation in pattern and composition of the vegetation. Owing to their burrowing activities, conditions for pioneer stages of vegetation succession are maintained and developments into shrub structures are retarded and locally sometimes even controlled. The number of rabbits in an area is correlated with the amount of short grazed vegetation. A study on an inland area showed that rabbit numbers decreased wtih a development of rough vegetation due to a gradual reduction in stocking rate of horses (Oosterveld 1983, Fig 5). In general, large herbivores improve the habitat and thereby help improve the living conditions for virtually all small herbivores. Introduction of a grazing regime always results in higher numbers of small herbivores. During this symposium Leach (1985) presented a clear example, where the cessation of grazing at Tentsmuir resulted into a strong reduction in rabbit numbers. The dune slack areas, considered as overgrazed before, turned into a birchwood. The management history of the island of Rhum has made it quite obvious that some type of grazing management was necessary there in order to keep conditions fit for deer.

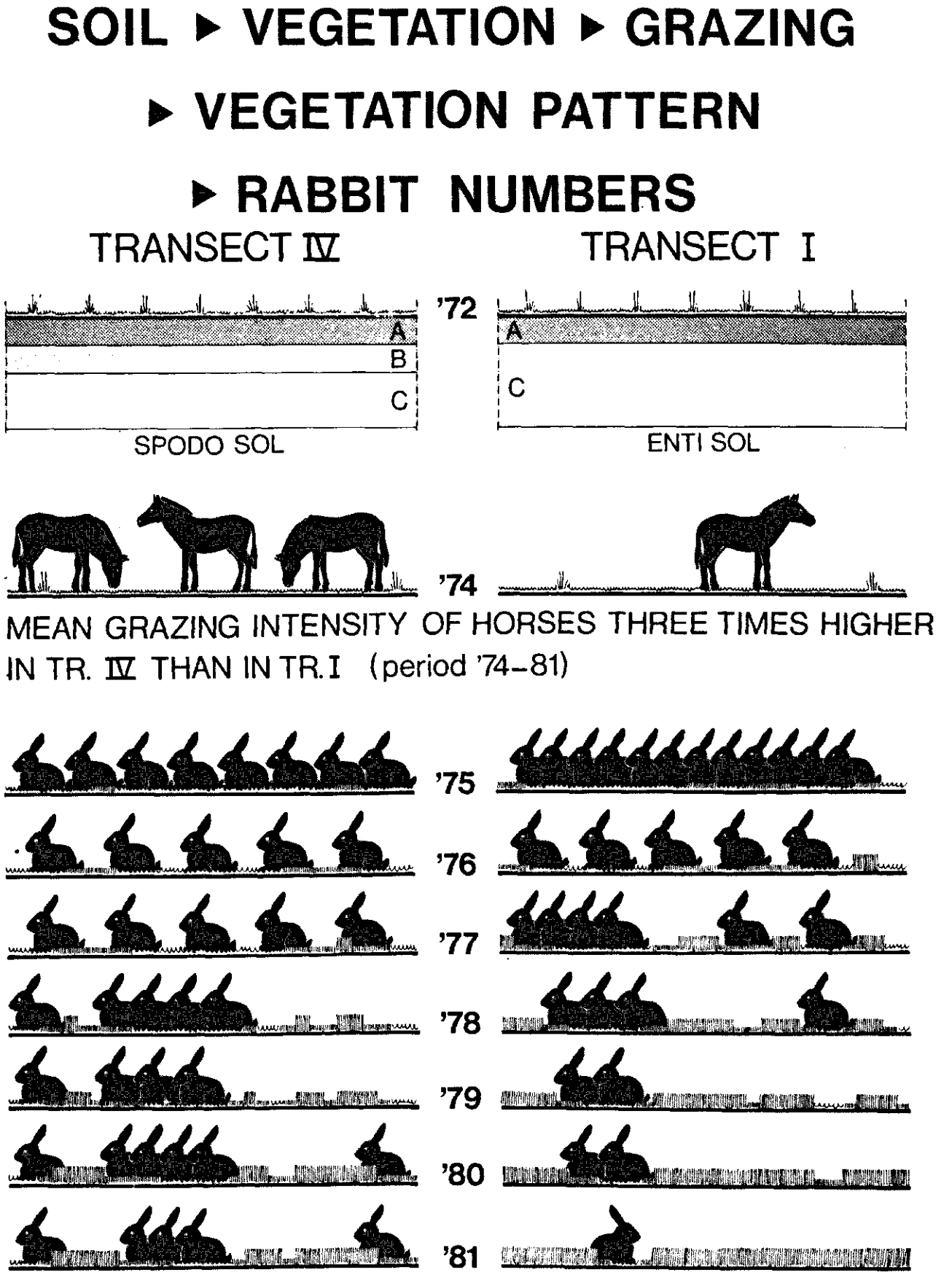


Figure 5

Effect of changes in stocking rate of horses on rabbit numbers.

Management and research, concluding remarks

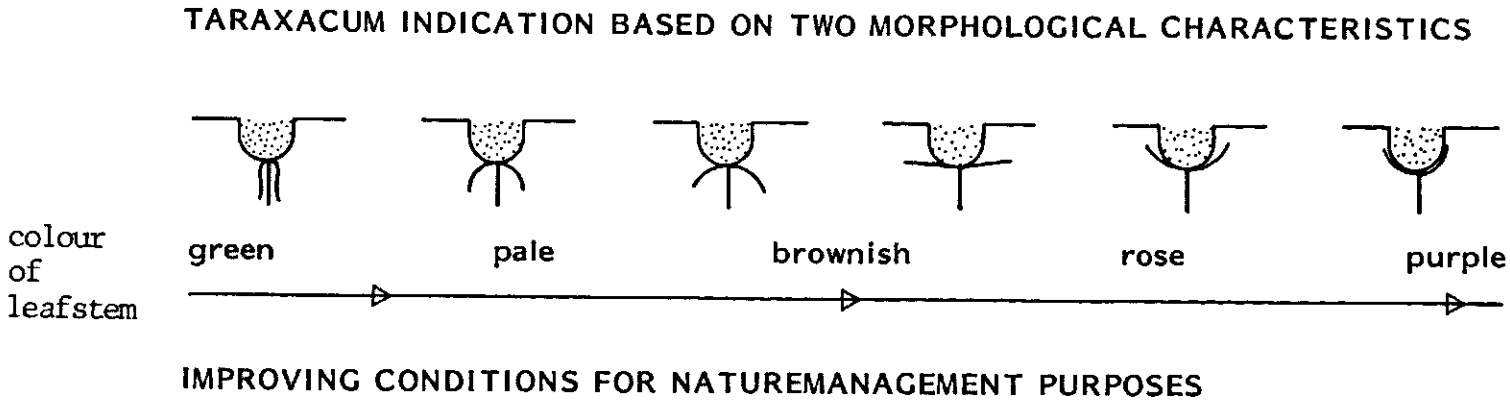
Reviewing the recent history of sand dune and saltmarsh management in The Netherlands one can say that mistakes have been made and have been repeated later in other areas. One reason could be that the complexity of the relations between the abiotic and biotic components in the systems were not properly understood and that management was based on simple presuppositions of an operational kind (cow eats orchids, therefore no cows etc.). Short duration research has often strengthened these ideas, especially where general conclusions as to management of an area were based upon detailed research into one or a few species or factors of importance.

Constancy of management practices is an important factor in maintaining the desired environmental conditions. Moreover, without constancy management impact cannot be investigated properly. Abrubt changes always lead, in the beginning, to negative effects for natural features. Gradual changes, especially when grazing is reduced to lower stocking rates, may improve conditions for the occurrence of rare species. As the well-being of species in an area is our main criterium for measuring the results of management practices, more research into the indicative value of organisms is required. The dandelions of the very common Taraxacum spp. for instance appeared to be a fair tool for the rapid assessment of improving or worsening conditions with respect to nature conservation purposes (Oosterveld 1983b, Fig. 6).

Grazing cannot be considered as one single parameter. Results are dependent on the kind of animal used, stocking rates and the prevailing and overruling conditions of the area involved such as geomorphological and soil characteristics. For the development of new areas and the improvement of abandoned fields any type of grazing will cause a differentiation in local conditions so that more species can make use of such areas. As long as grazing animals can stay alive independent of man within an area, using the available vegetation production, harmful effects on natural features are not to be expected. If not, lowering of the stocking rate or a change in grazing regime has to be considered (for instance seasonal instead of continuous grazing). So far in The Netherlands no species of interest to nature conservation has disappeared from areas with low stocking rates. On the contrary several species reappeared or became more firmly established. In addition at low stocking rates, any special additional measures thought to favour one or more species, in terms of protection from grazing, should be regarded as a waste of time and money.

Figure 6

Changes in morphology showing improving conditions for nature conservation.



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